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PLASMA DISPLAY PANEL AND A DRIVING METHOD THEREOF

BACKGROUND OF THE INVENTION

The present invention relates to a plasma display panel (hereinafter referred to as a "PDP") and a driving method thereof, and more particularly to a plasma display panel in which a plurality of row and column electrodes are arranged to be directly crossed from one another in a plurality of cells, and one row electrode is concerned in the electric discharge of two adjacent cell groups, thereby enhancing the brightness characteristic and embodying simple structure thereof.

A PDP is a flat panel display for displaying image sequence or still picture by using the gas discharge phenomenon. The screen is divided into a plurality of cells by row and column electrodes arranged on the upper and lower glass substrates, and images are displayed on the panel by the selective discharge generated inside of each cell.

As a representative example of a conventional PDP, FIGS. 1 to 3 illustrate a 3-electrode surface discharge alternating current (AC) PDP. FIG. 1 is a separated perspective view of the upper and lower substrates, FIG. 2 is a partial cross-sectional view of the upper substrate and FIG. 3 is a view showing the arrangement of the electrodes.

The conventional 3-electrode surface discharge AC PDP has an upper substrate 10 as a display surface of the image and a lower substrate 20 combined to the upper substrate 10 in parallel with a predetermined distance.

The upper substrate 10 has a row electrode 30 (hereinafter may be referred to as a "scan electrode 31" and a sustain electrode 32") formed at the surface facing the lower substrate 20, for dividing cells in a column direction by pair, an insulating layer 40 formed to surround the row electrode 30, for limiting the discharge current, and a protecting layer 50 formed below the insulating layer 40, for protecting the row electrode 30.

Each of the scan electrode 31 and sustain electrode 32 has a transparent electrode 31a, 32a made of ITO (Indium-Tin Oxide) with the width of about 300 μm , and an opaque electrode 31b, 32b made of metal with the width of about 50–100 μm .

The lower substrate 20 has a barrier rib 60 for forming a discharge space by dividing the cells in a row direction, a column electrode 70 (hereinafter referred to as an "address electrode") formed to be crossed with the row electrode 30 between the barrier ribs 60, and a phosphor layer 80 formed on the surface of the barrier rib and the surface of the lower substrate in the discharge space to surround corresponding address electrode 70, for emitting a visible ray at the discharge.

The PDP structured as described above generates a visible ray by exciting the phosphor to the ultraviolet ray generated at the discharge between electrodes, and such a discharge will be described with reference to FIGS. 4 to 5.

FIGS. 4 and 5 show the driving wave forms applied to each electrode and the processing states of the wall charge of corresponding cell according to the driving wave forms.

Since it is difficult to adjust the strength of the discharge in the PDP, the grey level of a pixel is embodied by adjusting the discharge number per unit time. One picture element is composed of three discharge cells of R, G and B. In the case of 256 grey levels, if the discharge number of each cell is divided into 0–255 every frame, the brightness of 256 grey levels can be embodied according to the discharge number.

The discharges selectively occurred in each cell are composed of an address discharge for addressing a luminous

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picture element, a sustain discharge for sustaining the discharge of the cell and an erase discharge for stopping the sustaining of the discharge cell.

Here, the wall charge is formed on the insulating layer 40 near the scan electrode 31 and sustain electrode 32 in the discharge space by the address discharge between the address electrode 70 and the scan and sustain electrodes 31 and 32, and the wall charge is sustained by the sustain discharge generated between the scan electrode 31 and the sustain electrode 32.

If the driving wave forms shown in FIG. 4 are applied to the electrodes 31, 32, 70, the processing states of the wall charge in the sections (a) to (h) are shown as the states (a) to (h) in FIG. 5.

That is, there was no wall charge in the discharge cell before the state (a) of FIG. 5. If an address pulse Va and a write pulse Vw are applied to the address electrode 70 and the scan electrode 31 in the section (a), there occurs an address discharge between the address electrode 70 and the scan electrode 31. Then, there forms a wall charge in the cell at the section (b) after the address discharge.

In this case, most of the wall charge are formed at the scan electrode 31 and the sustain electrode 32. The write pulse Vw has a width of over 2 μs and this width corresponds to the time required in forming the wall charge.

If a sustain pulse Vs is applied to the scan electrode 31 and the sustain electrode 32 at the section (c), there occurs a sustain discharge between the scan and sustain electrodes 31 and 32. Then, after the first sustain discharge, the wall charge opposite to that at the section (b) is formed at the section (d).

In this case, the sustain voltage of the electrodes 70, 31, 32 may be lower than the difference of the write voltage between the address electrode 70 and the scan electrode 31. This is because of the wall charge formed on the insulating layer 40 and there occurs no sustain discharge at the cell having no wall charge.

At the sections (e) and (f), there occurs a sustain discharge by the sustain pulse Vs and the wall charge opposite to that at the section (d) is formed after the sustain discharge.

Hence, one sustain period is from the section (c) to the section (f), and the discharge number during one sustain period is 2.

The erase discharge occurs at the section (g) by the erase pulse Ve. The erase pulse Ve has a width of less than 1 μs and the voltage of the erase pulse is lower than that of the sustain pulse Vs. There occurs a discharge between the scan and sustain electrodes 31 and 32 by this erase pulse Ve, but the cell has no wall charge at the section (h), because there was no time to form the wall charge, and thus there occurs no discharge even though the sustain pulse Vs is applied.

Accompanied by such a discharge process, the discharge gas injected to the discharge space of corresponding cell is ionized into an electron and an ion, thus generating ultraviolet rays. The phosphor layer 80 is excited by the ultraviolet rays, to emit a visible ray. Thereafter, if the visible ray passes through between paired row electrodes 30, i.e., between the scan electrode 31 and the sustain electrode 32 and then exits to the exterior, the image display by the luminescence of corresponding cell can be perceived from the exterior.

In the image display process, the brightness characteristic and the luminescence efficiency are determined according to the amount of the visible rays exited to the exterior, and the exit amount of the visible rays is determined by various factors.

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Particularly, in the condition that other factors including the luminescence characteristic of the phosphor are the same, the exit amount of the visible rays is determined by the aperture rate of the cell, i.e., the spaced distance between the scan electrode 31 and the sustain electrode 32. Since the transparent electrodes 31a and 32a slightly affects, it can be said that the exit amount of the visible rays is determined by the spaced distance r between the opaque electrodes 31b and 32b, and the greater the spaced distance, the more improved the brightness characteristic and luminescence efficiency.

In the panel structure of the conventional technique as described above and the accompanying driving method, the cells are divided in a column direction by the paired row electrodes, i.e., the paired scan electrode 31 and sustain electrode 32, and for the sustain of the luminescence, it is necessary to generate a sustain discharge between a pair of row electrodes 30 arranged in corresponding cell.

Hence, the spaced distance r between the opaque electrodes 31b and 32b is limited by the maximum distance between the scan electrode 31 and the sustain electrode 32 arranged in each cell, and this causes a problem that the range to improve the brightness characteristic and luminescence efficiency is limited even though the spaced distance r between the adjacent opaque electrodes 31b and 32b is made great.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an improved PDP in which the cell is divided in a column direction by one row electrode and corresponding row electrode is concerned in the discharge of two adjacent cells and a driving method thereof, thereby increasing the spaced distance between the opaque electrodes, i.e., the aperture rate of the cell to enhance the brightness characteristic and luminescence efficiency, and reducing the number of required row electrodes to simplify the structure of the panel.

To achieve the above object of the present invention, there is provided a plasma display panel in which a plurality of row electrodes are arranged to be crossed with a plurality of column electrodes between two substrates which are combined in parallel.

In such a PDP, the row electrode has a transparent electrode with a plurality of projecting electrode parts which are alternately projected upward and downward with a predetermined width along a row axis and an opaque electrode formed at the lower part of the row axis of the transparent electrode. The column electrode is arranged on a column axis of the projecting electrode part and the row electrode is concerned in the discharge of two column-direction cell groups by the interaction with two other row electrodes adjacent in a column direction.

Preferably, the predetermined width is the width of a unit cell.

Preferably, two row electrodes adjacent in a column direction are formed to be in parallel in a column direction by the projecting electrode parts spaced by a predetermined distance.

Selectively, the opaque electrode is injected with a predetermined width at the position and direction where the projecting electrode part is arranged.

Selectively, the opaque electrode is projected with a predetermined width at the position and from the inverse direction where the projecting electrode part is arranged.

The method for driving the plasma display panel in which a plurality of row electrodes are arranged to be crossed with

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a plurality of column electrodes between two substrates in a plurality of cells, and the row electrode is concerned in the discharge of two adjacent row-direction cell groups by the interaction with two other row electrodes adjacent in a column direction, comprises the steps of applying a scan voltage between the column electrode and row electrode corresponding to a discharge cell, thus generating an address discharge between corresponding column and row electrodes, applying a sustain voltage to the row electrode, thus generating a sustain discharge between the row electrode and other row electrode adjacent to the row electrode, applying the sustain voltage to the other row electrode, thus generating the sustain discharge again between the row electrode and the other row electrode.

Preferably, the discharge start voltage of the discharge cell is higher than the addition of a wall voltage by the address discharge to the scan voltage applied to the adjacent cell.

Preferably, the discharge start voltage of the discharge cell is lower than the addition of a wall voltage by the address discharge to the sustain voltage applied to the adjacent row electrode.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a separated perspective view showing the upper and lower substrates of a conventional plasma display panel;

FIG. 2 is a partial cross sectional view showing the upper substrate of FIG. 1;

FIG. 3 is a view showing the arrangement of the PDP according to a prior art;

FIG. 4 is a view showing the driving wave forms applied to each electrode according to a prior art;

FIG. 5 is a view showing the processing states of the wall charge of corresponding cell according to the driving wave forms of FIG. 4;

FIG. 6 is a partial cross sectional view showing the upper substrate of the PDP according to a preferred embodiment of the present invention;

FIG. 7 is a view showing an arrangement of the electrodes in the PDP having the upper substrate of FIG. 6;

FIG. 8 is a view showing the driving wave forms applied to each electrode according to the present invention;

FIG. 9 is a view showing the processing states of the wall charge of corresponding cell according to the driving wave forms of FIG. 8;

FIG. 10 is a view showing the arrangement of the phosphor doped inside of each cell according to the present invention; and

FIG. 11 is a view showing an arrangement of the electrodes in the PDP according to another preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention will be described in detail with reference to the accompanying drawings.

Throughout the drawings, it is noted that the same reference numerals of letter will be used to designate like or equivalent elements and a repeated description will be omitted for clarity.

FIG. 6 is a partial cross sectional view showing an upper substrate of a PDP according to a preferred embodiment of